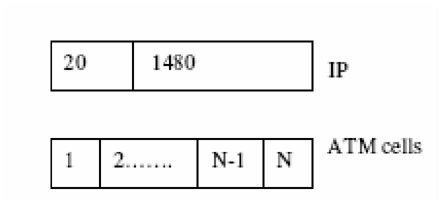
Packet and Circuit Switching

1. An IP packet consists of 20 bytes of header and 1480 bytes of payload. The IP packet is to be tunneled across an ATM backbone to another IP network. Suppose the packet is mapped into ATM cells that have 5 bytes of header and 48 bytes of payload. How much of the resulting cell stream is header overhead?



Solution:

1500 Bytes IP packets are divided into N cells where each cell is 48 bytes (ATM).

$N = \frac{1500}{48}$ ***= 31.25 = 32 ATM cells.*** ***[Note : No part cells. Must round up!]***

Each ATM cells has 5 bytes of header.

Hence, total overhead = 32 × 5 (ATM cells) + 20 (from IP) = 180 Bytes

$$\textbf{Header Overhead \%} = \frac{TotalOverHeadBytes}{TotalData} \times 100$$

$$= \frac{180}{53 \times 32} \times 100$$

= 10.61 %

1. Consider the queuing delay in a router buffer (preceding an outbound link). Suppose all packets are L bits, the transmission rate is R bps, and N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queuing delay of a packet. The queuing delay for the first packet is zero.

SOLUTION:

It takes LN/R ***seconds to transmit the*** N ***packets. Thus, the buffer is empty when a batch of*** N ***packets arrive.***

The first packet has no queueing delay. The 2nd packet has a queueing delay of L/R ***seconds. The*** n ***th packet has a delay of*** $(n-1)L/R$ ***seconds.***

The average delay is

$$\frac{1}{N}\sum_{n=1}^{N}(n-1)L/R = \frac{L}{R}\frac{1}{N}\sum_{n=0}^{N-1}n = \frac{L}{R}\frac{1}{N}\frac{(N-1)N}{2} = \frac{L}{R}\frac{(N-1)}{2}.$$

2. Consider sending a file of $F=M.L$ bits over a path of Q links. Each link transmits at R bps. The network is lightly loaded so there are no queuing delays. When a form of packet switching is used, the $M.L$ bits are broken up into M packets, each packet with L bits. Propagation delay is negligible.

(a) Suppose the network is using message switching instead of packet switching; $2h$ bits are added to the message, and the message is not segmented. How long does it take to send the file.

SOLUTION:

The time required to transmit the message over one line is (L*M + 2*h) / R.
Then the time required to transmit over Q links would be

Q * (L*M + 2*h) / R seconds

(b) Suppose the network is a circuit switched network. Further suppose that the transmission rate of the circuit between the source and the destination is R bps. Assuming t_s set-up time and h bits of header appended to the entire file, how long does it take to send the file.

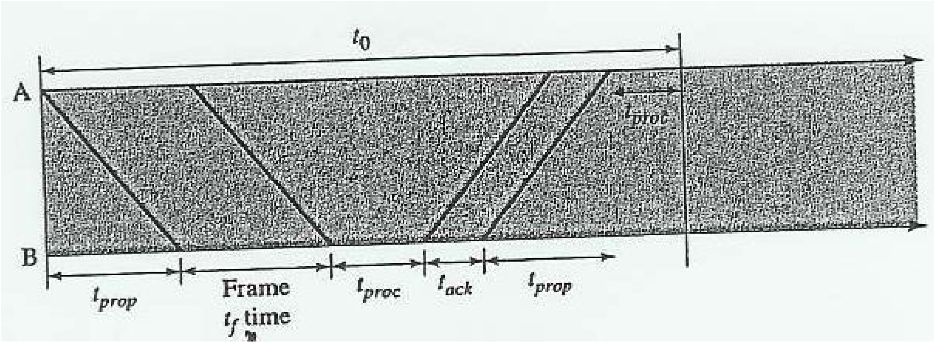
SOLUTION:

Since there is no store and forward delays at the links, the total delay is setup time + frame transmission time:

= ts + [(h + L*M) / R]

3. Suppose that frames are 1000 bytes long including 40 bytes of overhead. Also assume that ACK frames are 15 bytes long. Calculate the efficiency of stop-and-wait ARQ in a system that transmits at R=1 Mbps and reaction time $2(t_{prop}+ t_{proc})$ of 1 ms.

(Hint: See Diagram Below)



$$t_o = t_{frame} + t_{prop} + t_{proc} + t_{ack} + t_{prop} + t_{proc}$$

$$= t_{frame} + 2(t_{prop} + t_{proc}) + t_{ack}$$

$$t_{frame} = L/R = 1000*8/10^6 = 8 \text{ msec}$$

$$t_{ack} = 15*8/10^6 = 0.12 \text{ msec}$$

$$2(t_{prop} + t_{proc}) = 1 \text{ msec}$$

$$t_o = 8 \text{ msec} + 0.12 \text{ msec} + 1 \text{ msec} = 9.12 \text{ msec}$$

$$t_{overhead} = 40*8/10^6 = 0.32 \text{ msec}$$

Efficiency of Data Transmission $= \dfrac{t_{frame} - t_{overhead}}{t_o} * 100$

$$= \frac{8 \text{ msec} - 0.32 \text{ msec}}{9.12 \text{ msec}} * 100$$

$$= 84.20 \%$$